DCR SWM/E&S "QUANTITY CONTROL" CRITERIA DISCUSSION

1. Runoff Volume Reduction and/or Recharge Requirements: NONE currently. Typically, this type of requirement targets the rainfall events that create little or no stormwater runoff, but that produce much of the annual groundwater recharge that occurs at the development site.

Members of DCR's Technical Advisory Committee (TAC) for the Stormwater Management Regulation revision have recommended adding (unspecified) requirements pertaining to groundwater recharge and/or runoff reduction. However, ***it is unclear (1) whether there is a clear enough option available that is also politically acceptable to the range of stakeholders involved with the state's Stormwater Management Program, or (2) whether a separate requirement will be necessary, given the runoff reduction methodology DCR is proposing.***

The intent of the recharge and/or volume reduction criterion is to maintain groundwater recharge rates at development sites to preserve existing water table elevations and support natural flows in streams and wetlands. Under natural conditions, the amount of recharge that occurs at a site is a function of slope, soil type, vegetative cover, precipitation and evapotranspiration. Sites with natural ground cover, such as forest and meadow, typically exhibit higher recharge rates, lower runoff volumes and greater transpiration losses than sites dominated by impervious cover. Since development increases impervious cover, a net decrease in recharge rates is inevitable.

As noted above, the water quality protection criteria proposed to DCR by the CWP rests on a foundation of runoff volume reduction. However, this is an integrated methodology based on the science of stormwater management, rather than on a specific requirement set forth in the regulations. Therefore, ***DCR expects the regulations to result in substantial runoff reduction, including groundwater recharge, even if there is no stated requirement in the regulations.***

2. Water Quality Requirements (Treatment Volume): Currently aimed at capturing of the *first flush* of runoff; therefore, most treatment BMPs are sized based on capturing the first ½-inch to 1-inch of runoff from impervious surfaces. Typically the treatment volume targets the rainfall events that transport the majority of stormwater pollutants off of the development site.

Several years ago, as part of legislation introduced by Fairfax County addressing stream restoration projects, a definition of *"Water Quality Volume"* was added to the Stormwater Management Act. However, this definition was included to clarify issues pertinent to that specific legislation rather than water quality treatment of runoff in general. Stormwater management experts across the nation are moving away from focusing on the first flush and BMP pollutant removal efficiencies as the keys to managing water quality. The newer thinking is that we need to focus on runoff volume reduction as the principle method of reducing the mass load of pollution from runoff. Practices that are more purely treatment practices, such as filters, ponds and constructed wetlands, should be back-up solutions.

Chapter 2 of the current *Virginia Stormwater Management Handbook (1999)* also discusses the method recommended by the Center for Watershed Protection (CWP) that focuses on treating runoff from the 1-inch rainfall event (the 90th percentile rainfall event in the Chesapeake Bay

region). This approach is actually the foundation for what DCR is proposing for BMP treatment volumes, as discussed below.

***Proposed*:** The Center for Watershed Protection (CWP) has proposed to DCR that the treatment volume (Tv) for Level 1 treatment practices generally be treatment of the runoff from a 1-inch rainfall. Level 1 treatment practices are aimed at achieving the median removal rate for the target pollutant (in this case, phosphorus) reflected in the research projects included in the National Pollutant Removal Performance Database (NPRPD). The CWP has proposed that the Tv for Level 2 treatment practices vary, specific to each practice, as a multiple of the Level 1 version of that practice (multiples are 1.1, 1.25 or 1.5, depending on the practice). Therefore, the Tv is specific to each practice and each level of the practice. These recommendations have been developed based on an extensive review of the NPRPD, ferreting out the critical design features that appear to have resulted in improved BMP performance.

3. Channel Protection Requirements: Targets the storm events that generate bankfull and sub-bankfull flows in downstream channels and cause downstream channel erosion. Currently, the SWM regulations require compliance with Minimum Standard 19 of the Virginia Erosion and Sediment Control Regulations (4 VAC 50-30-40.19). This standard requires that *properties downstream from development sites be protected from sediment deposition, erosion, and damage due to increases in volume, velocity, and peak flow rate of stormwater runoff.* The specific design criteria specify that downstream *natural channels* be analyzed for adequacy to assure they can convey the post-development 2-year/24 hour peak discharge within the channel banks and at a non-erosive velocity. In addition, *man-made channels* must be analyzed for adequacy to assure they can convey the 10-year/24-hour peak discharge within the channel banks and the 2-year/24-hour discharge at a non-erosive velocity. This requirement typically results in employment of practices that capture the post-development runoff volume, with the release approximating the pre-development storm flow.

Proposed*:** DCR does not yet have a specific proposal for an updated channel protection requirement. That is one of the purposes of this Stormwater Quantity Control Work Group. However, the CWP has proposed that DCR consider moving to a different design storm for this purpose. Other jurisdictions in the Bay region have moved to requiring detention of runoff from the *post-development* one-year/24-hour storm, with a release period of 24 hours. However, some stormwater management experts believe even this storm may result sizing BMPs to be larger than necessary to adequately protect stream channels. ***This is one of the most important issues the Work Group needs to discuss.

4. Overbank Flood Protection Requirements: Currently, DCR requires control of the post-development 10-year/24-hour storm back to the pre-development release rate. This targets the large and relatively infrequent storm events that cause streams to leave their banks and spill over into the floodplain, causing damage to infrastructure and streamside property. ***DCR does not expect to change this criterion, since it is widely accepted and used for this purpose.***

5. Extreme Flood Protection Requirements: This targets the largest, most infrequent storm events that cause catastrophic flooding and threaten floodplain structures and public safety (e.g., 100-year flood). DCR does not require that BMPs be sized to hold back the 100-year storm, but

practices must be designed by bypass flows larger than the 10-year storm. For example, emergency spillways of ponds must be able to safely bypass the 100-year/24-hour storm in order to protect the structural integrity of the dams and risers. ***DCR does not expect to change this criterion, since it is widely accepted and used for this purpose.***

The Federal Emergency Management Agency (FEMA) maps the 100-year flood plain, based on the expected flood elevation of the 100-year frequency design storm. The mapped 100-year floodplain is important because it is used to designate and implement the National Flood Insurance Program. Most localities in Virginia have a Floodplain Management Ordinance that controls development within the 100-year floodplain.

The relationship between the five stormwater sizing criteria is best understood visually as a layer cake, with recharge volume being the thinnest layer at the top and extreme storm control comprising the thickest layer at the bottom. **Figure 1** illustrates the relationship between the five stormwater sizing criteria.

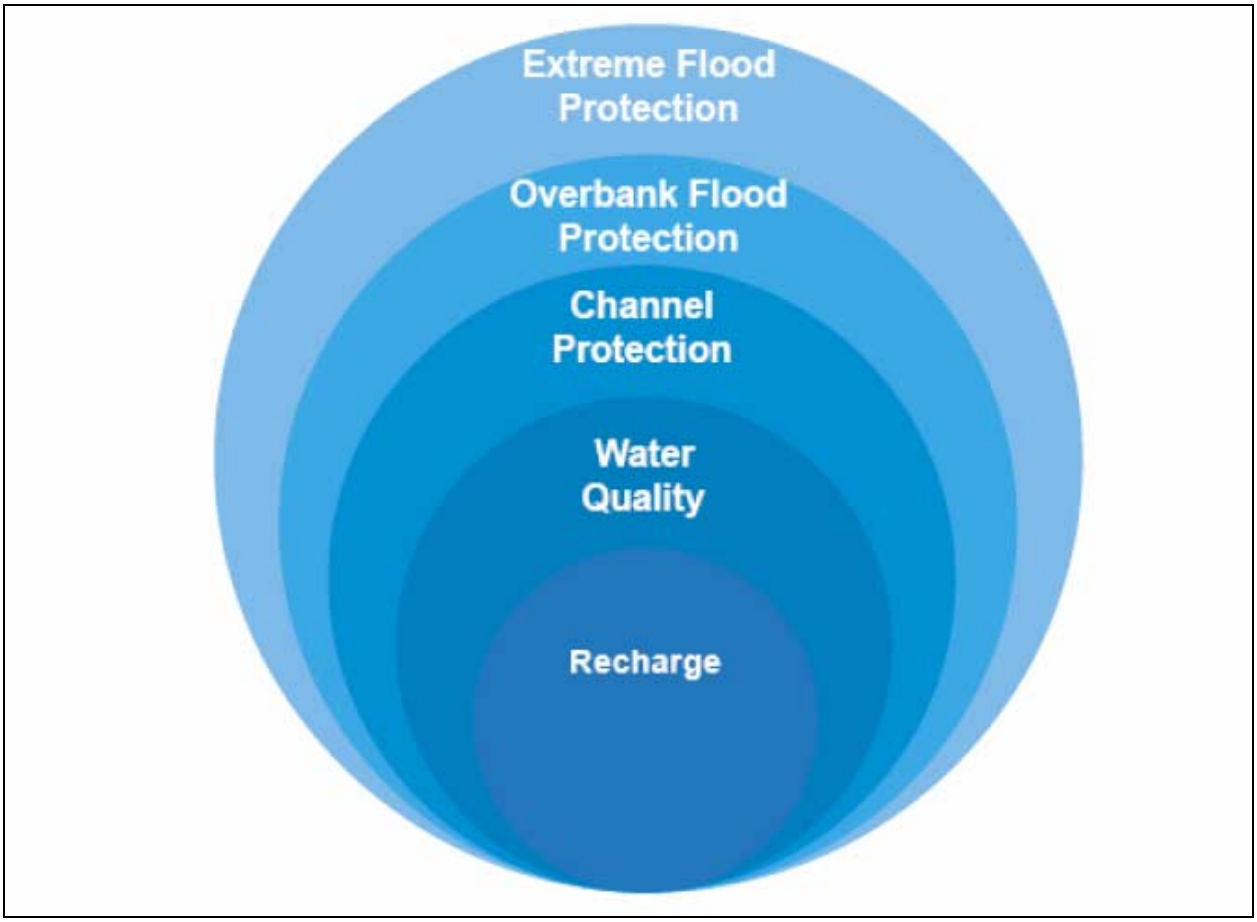

Figure 1: Graphic Representation of the Unified Stormwater Sizing Criteria

RECHARGE AND VOLUME REDUCTION CRITERIA (RR_v)

A number of states have recently developed design criteria to promote recharge and/or runoff volume reduction at development sites **(Table 1)**. Each of the states use a slightly different approach; the pros and cons of each design approach can be found in the issue papers developed for the recently published *Minnesota Stormwater Manual (2006)*

The most widely applied recharge and/or volume reduction sizing criterion is the recharge volume approach. The objective of the criterion is to mimic the average annual recharge rate for the prevailing hydrologic soil group(s) present at a development site. Therefore, the recharge volume is calculated as a function of annual pre-development recharge for a given soil group, average annual rainfall volume, and the amount of impervious cover at a site. The recharge volume is considered to be part of the total water quality volume provided at a development site and, therefore, does not require additional structural BMPs when water quality treatment is also required (see below). Additionally, recharge can be achieved either by structural BMPs (e.g., infiltration, bioretention, and filtration), non-structural BMPs (e.g., impervious disconnection, open space preservation), or a combination of both.

Table 1: Example Recharge and Volume Reduction Criteria	
MD/MA	Recharge volume based on regional annual recharge rates for hydrologic soil groups present at the site
NJ	Use of specialized recharge model to determine location and volume of recharge needed at the site
WI/PA	Infiltrate the increase in runoff volume from pre- to post development for the two year-24 hour design storm event
MN	Allow for stormwater credits that provide recharge
Various	Infiltrate the first half inch of runoff

Recharge and/or volume reduction stormwater criteria offer additional stormwater management benefits, since they promote more on-site infiltration of stormwater runoff. This enables communities to offer stormwater credits that reduce the water quality storage volume. Recharge credits provide real incentives to apply low-impact development techniques at development sites that can reduce the number, size and cost of structural stormwater BMPs. ***To maximize recharge and volume reduction, designers must explore how to use pervious areas for infiltration early in the site layout process.***

Note, however, that the infiltration of polluted stormwater runoff is not always desirable or even possible at some development sites. Therefore, most recharge and/or infiltration requirements include criteria to reflect special site conditions, protect groundwater quality, and avoid common nuisance issues. For example, they may require:

- The pretreatment of stormwater runoff prior to infiltration in some land use categories or pollution source areas (e.g. parking lots, roadways).
- That recharge be restricted or prohibited at specific industrial, commercial and transport-related operations designated as potential stormwater hotspots.

- That recharge be prohibited or otherwise restricted within the vicinity of wellhead protection areas, individual wells, structures, basins.
- That recharge be restricted or prohibited within certain geological zones, such as active karst, and in areas adjacent to unstable or fill slopes.
- That recharge requirements be reduced or waived for minor redevelopment projects.

DCR expects to include such specific criteria in the design standards and specifications for the various treatment practices that accomplish recharge and runoff reduction.

CHANNEL PROTECTION CRITERIA (Cp_v)

Historically, two-year peak discharge control has been the most widely applied local criteria to control channel erosion in most states, and many communities continue to use it today. Two-year peak control seeks to keep the post-development peak discharge rate for the 2-year/24-hour design storm at pre-development rates. The reasoning behind this criterion is that the bankfull discharge for most streams has a recurrence interval of between 1 and 2 years, with approximately 1.5 years as the most prevalent **(Leopold, 1964 and 1994)**, and maintaining this discharge rate should act to prevent downstream erosion.

Recent research, however, indicates that two-year peak discharge control does not protect channels from downstream erosion and may actually contribute to erosion since banks are exposed to a longer duration of erosive bankfull and sub-bankfull events **(MacRae, 1993, MacRae, 1996, McCuen and Moglen, 1988)**. Thus, while two-year peak discharge control may have some value for overbank flood control, it is not effective as a channel protection criterion, since it may actually extend the duration of erosive velocities in the stream and increase downstream channel erosion.

Regulators are being encouraged to adopt new channel protection criteria (and eliminate two-year peak discharge control requirements) when they revise or adopt local stormwater ordinances. Some examples of the channel protection criteria that are in use today are shown in **Table 2**.

Table 2: Example Channel Protection Criteria	
MD,VT,GA,NY	24 hour detention of the one-year 24 hour storm
WA	Match predevelopment peaks for duration of storms from 0.5 to 50 years using simulation models
ONT	Distributed Runoff Control
WI/MN	Infiltrate excess runoff volume from 2 year storm
Various	Control two year storm to one year levels
Various	Performance criteria, such as outlet energy controls, level spreaders, maintenance of stream buffers

The most widely recommended channel protection criterion in the last few years is to provide 24 hours of extended detention for the runoff generated from the 1-year/24-hour design storm. This runoff volume is stored and gradually released over a 24-hour period so that critical erosive

velocities in downstream channels are not exceeded over the entire storm hydrograph. As a very rough rule of thumb, the storage capacity needed to provide channel protection is about 60% of the one-year storm runoff volume. This channel protection criterion has recently been adopted by the States of Maryland, New York, Vermont, and Georgia, and is relatively easy to compute at most development sites using hydrologic models. However, as noted above, ***some stormwater experts are beginning to question whether even this design criterion will result in BMPs that are larger and more costly than needed to actually protect receiving channels.***

INTEGRATING MS-19 WITH CHANNEL RESULTING PROTECTION CRITERIA

One aim pertaining to the water quantity control criteria in the Stormwater Management (SWM) Regulations is to integrate the channel protection criteria currently set forth in the Erosion and Sediment (E&S) Control Regulations into the SWM Regulations, and having the E&S Control then refer to the SWM regulations.

As currently constructed, MS-19 has nearly two pages of specific criteria related to stream channel protection. However, the over-riding requirements are stated as performance criteria aiming to assure that runoff discharges into and *adequate channel* (NOT outfall), and that receiving channels/streams are protected from sediment deposition, erosion, and damage due to increases in volume, velocity and peak flow of stormwater runoff for the stated design storm (4 VAC 50-30-40.19). Furthermore, all protective measures are to be employed in a manner which minimizes impacts on the physical, chemical and biological integrity of the receiving waters (4 VAC 50-30-40.19.k).

There appears to be broad agreement that the channel protection criteria that Virginia has been requiring for many years *is not working effectively*. This is evidenced by the significant amount of stream channel degradation that has taken place, even with the current requirements in place. There also appears to be broad agreement among local and state government officials and consulting engineers and site designers that the criteria need to be improved to provide better protection and better accountability. The existing performance criteria appear to be reasonable for achieving the goal of effective channel protection. ***The challenge for the Work Group will be to improve the more specific criteria in a manner that comports with the general performance criteria.***

ACCOUNTING FOR THE EFFECT OF RUNOFF REDUCTION ON RUNOFF HYDROGRAPHS

See separate handout.

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